Landfill Methane and Climate Change

- Overview of Science and Regulation
- Status of Climate Action Team and AB 32 Landfill Methane Capture Strategy

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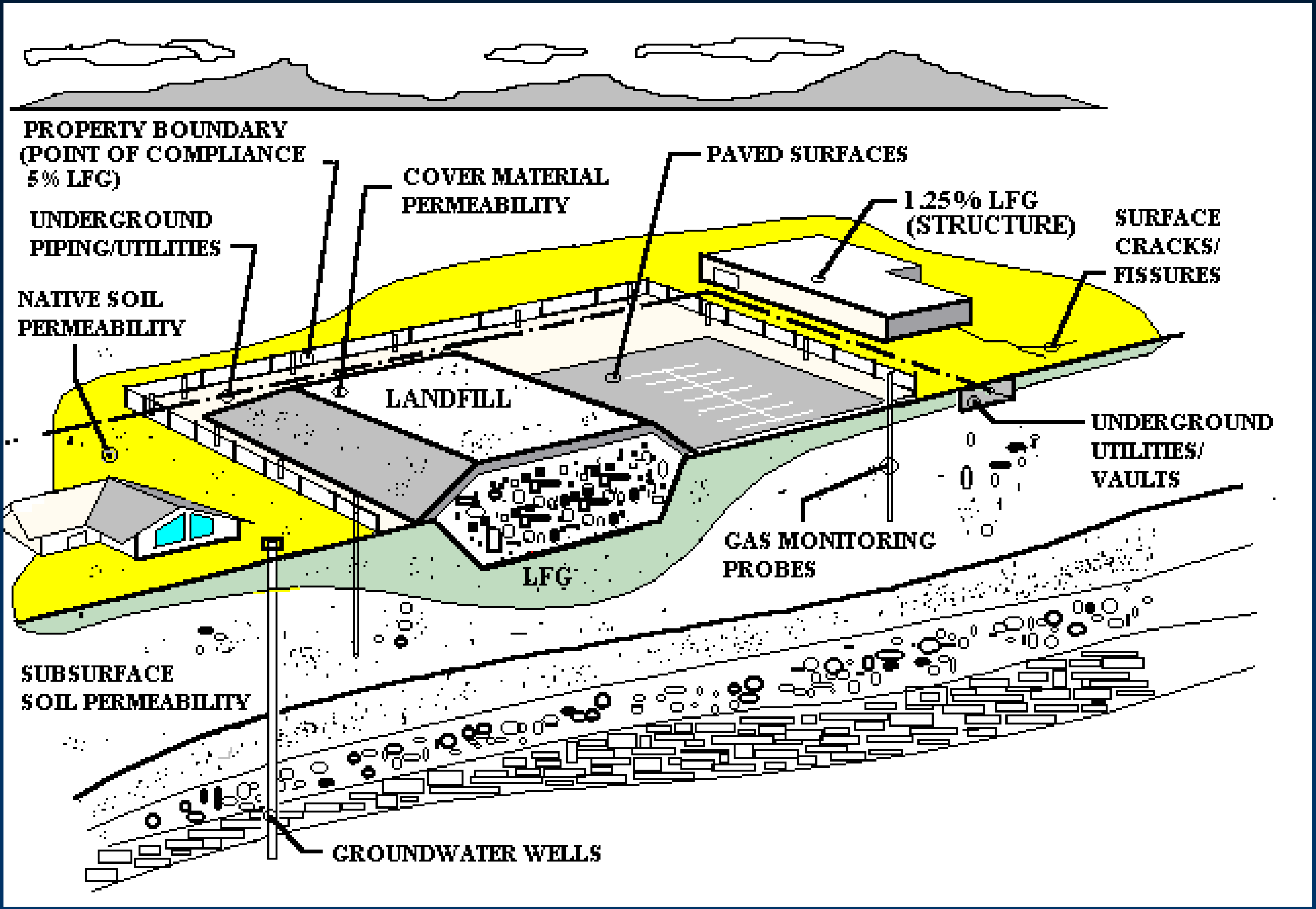
Landfill Gas

- Landfill gas is a complex decomposition product of waste in a sanitary landfill. Composition:
  - Methane (45-60%) and carbon dioxide (40-60%).
  - N_2 (2-5%), O_2 (0.1-1%), NH_3 (0.1-1%), Sulfides (0-1%), H_2 (0-0.2%), CO (0-0.2%).
  - Non-Methane Organic Compounds (NMOCs) 0.01-0.6%, other non-NMOC HAPs/TACs (e.g., Hg).
- Potential threats to public health and environment:
  - Explosive (5-15% methane in air).
  - Asphyxiant in confined spaces.
  - Odorous, toxic, and ozone precursor trace gases.
  - Methane contributes to climate change emissions.

Regulation of Landfill Gas

- Air Quality: Local Air Districts and ARB
  - NMOCs, VOCs, TACs/HAPS, odors, and criteria pollutants (NOx, CO, PM) from control devices.
  - District Rules and Permits which reflect Federal Clean Air Act NSPS/EG Rules and Title V Permits.
  - Climate Change/Greenhouse Gases: ARB (AB 32 2006).
- Water Quality: SWRCB/RWQCBs
  - Title 27 California Code of Regulations (27 CCR); Waste Discharge Requirements (WDRs).
- Explosive Gas Migration: CIWMB/LEA
  - 27 CCR §§20918-20939 which reflect RCRA Subtitle D; Solid Waste Facility Permit (SWFP).

Landfill Gas Migration



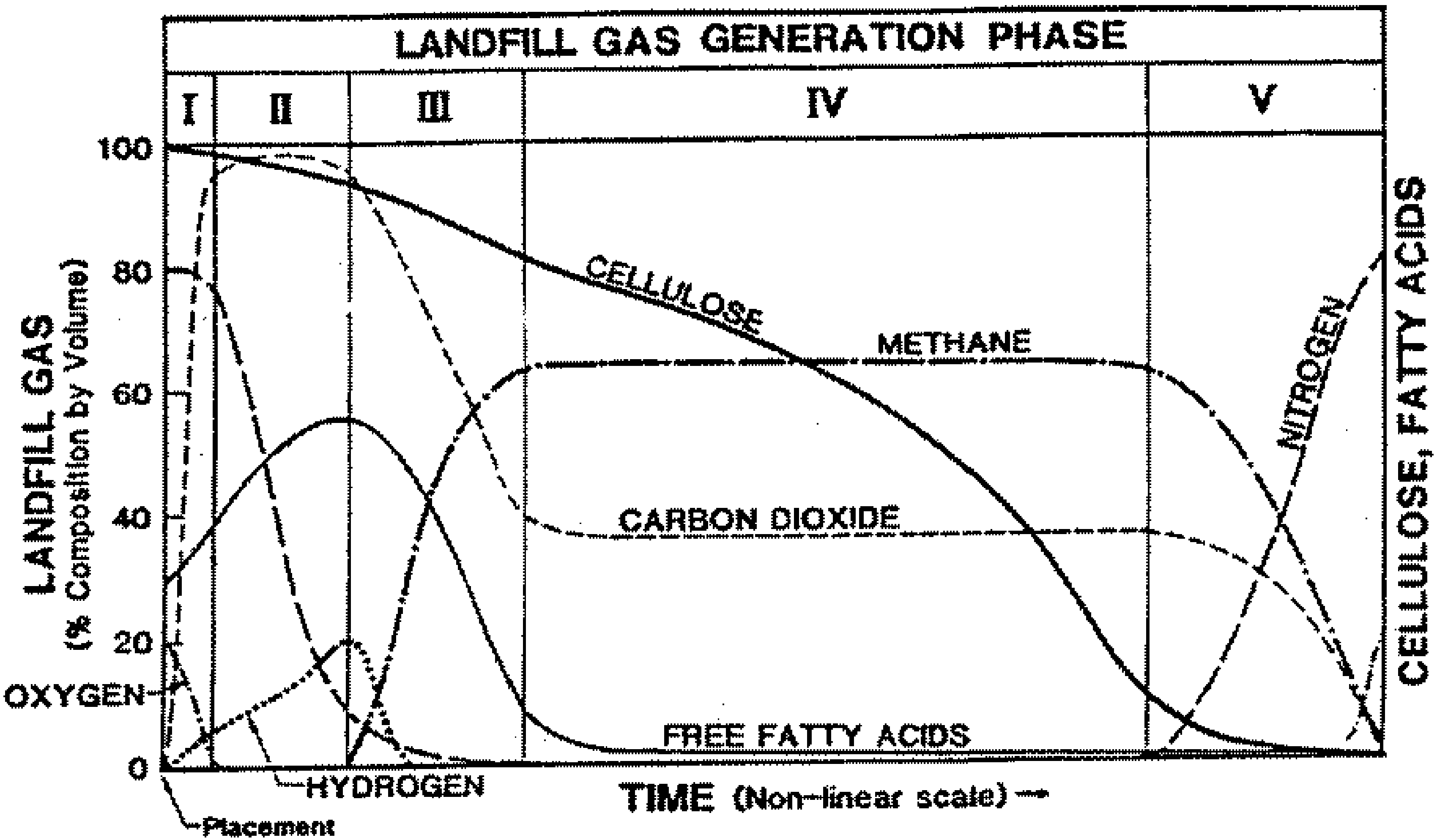
Landfill Methane as Greenhouse Gas

- Why is methane a greenhouse gas (GHG)?
  - Methane absorbs terrestrial infrared radiation (heat) that would otherwise escape to space.
  - Methane is 23x more potent by weight than CO_2 .
  - Higher rate of increase than CO_2 and reduction will have more rapid climate change response.
- USEPA estimates natural sources 40% and anthropogenic sources 60% (landfills, fossil fuel production, animal husbandry (livestock and manure), rice cultivation, biomass burning).

Landfill Methane (cont.)

- Landfill methane is produced by anaerobic biologic processes (methanogen bacteria) and depends on waste quantity, type, moisture, climate, and age.
- Methane not captured (naturally oxidized, in subsurface, or removed by controls) is released to atmosphere as fugitive emissions.
- Methane emissions typically estimated (*with high uncertainty*) by models and by direct measurement.
- Public domain models include EPA LandGEM (www.epa.gov/ttn/catc/products.html#software) and IPCC.

TYPICAL LANDFILL GAS GENERATION PATTERN



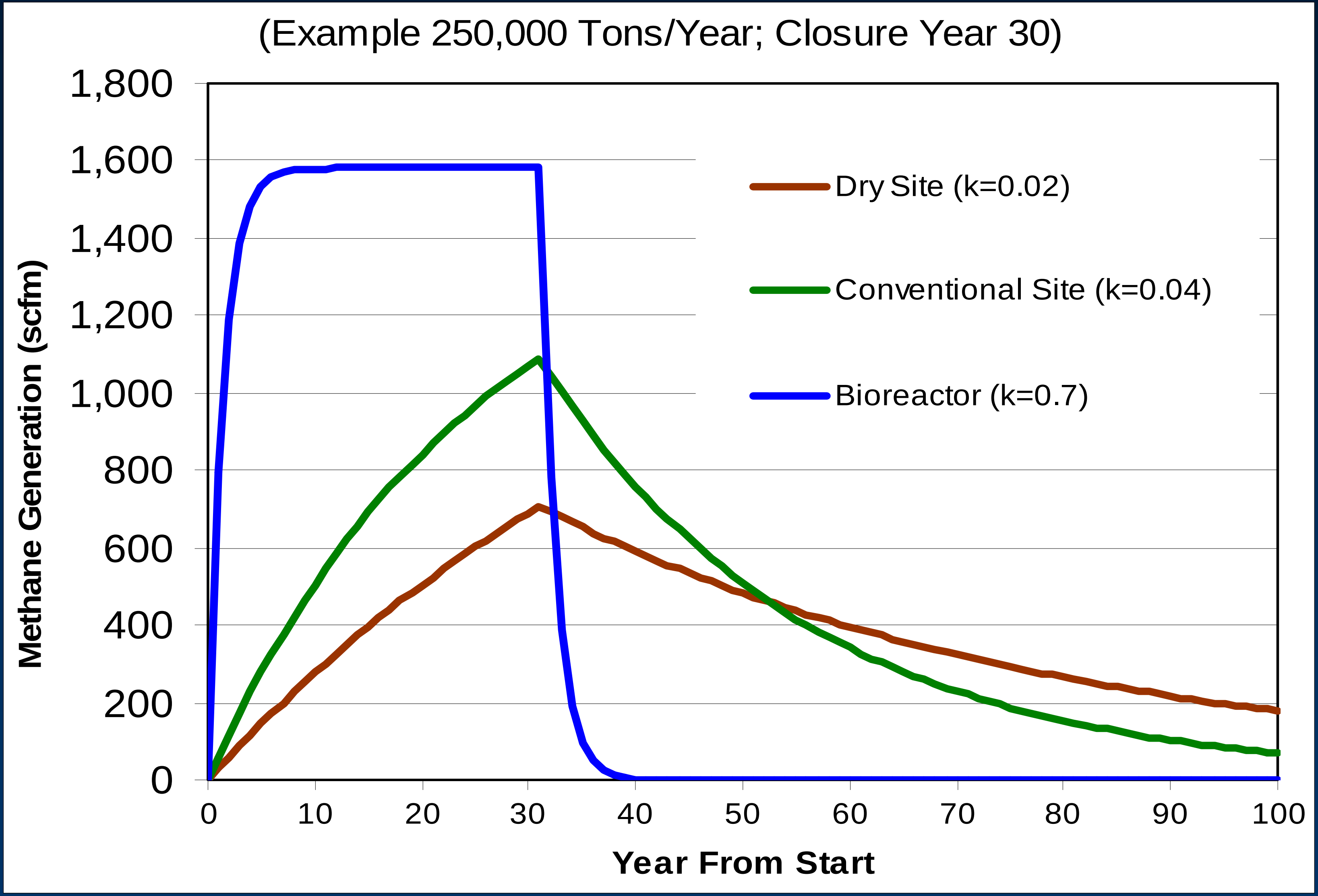
SOURCE: Farquar and Rovers, 1973, as modified by Rees, 1980, and Augenstein & Pacey, 1991

Figure 2. Typical landfill gas generation pattern

Landfill Methane Capture Efficiency

- Capture efficiency is controversial and a key measure of performance in reducing emissions.
- Estimated based on *modeled gas generation* and *measured gas that is flared or recovered*.
- Default capture efficiencies based on USEPA are 75% (with control) and 10% for natural oxidation. Actual capture may be higher or lower.
- Active projects to reduce uncertainty (CEC Study).

Landfill Gas Models- USEPA LandGEM

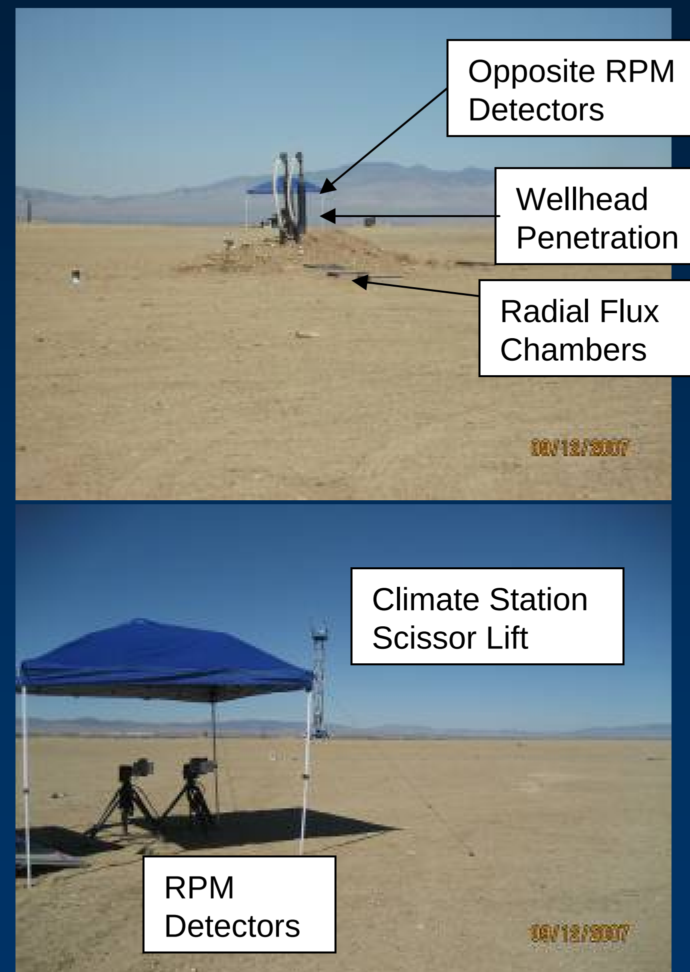


Landfill Gas Models Versus “Real World”

Bradley LF 19-AR-0004

Landfill Methane Direct Measurement

Lancaster Landfill 9/12/07



CEC Study (Bogner/Spokas)

- Investigate the use of data collected by CIWMB and Local Air District as predictive parameters.
- Collect 2 years of field data, using flux chambers to obtain emission factors. RPM at one landfill to provide additional field validation.
- Goal to create scientifically sound and practical detailed landfill methane emissions model and inventory methodology to account for variation across landfill site-specific characteristics, climate, and oxidation in cover soils.

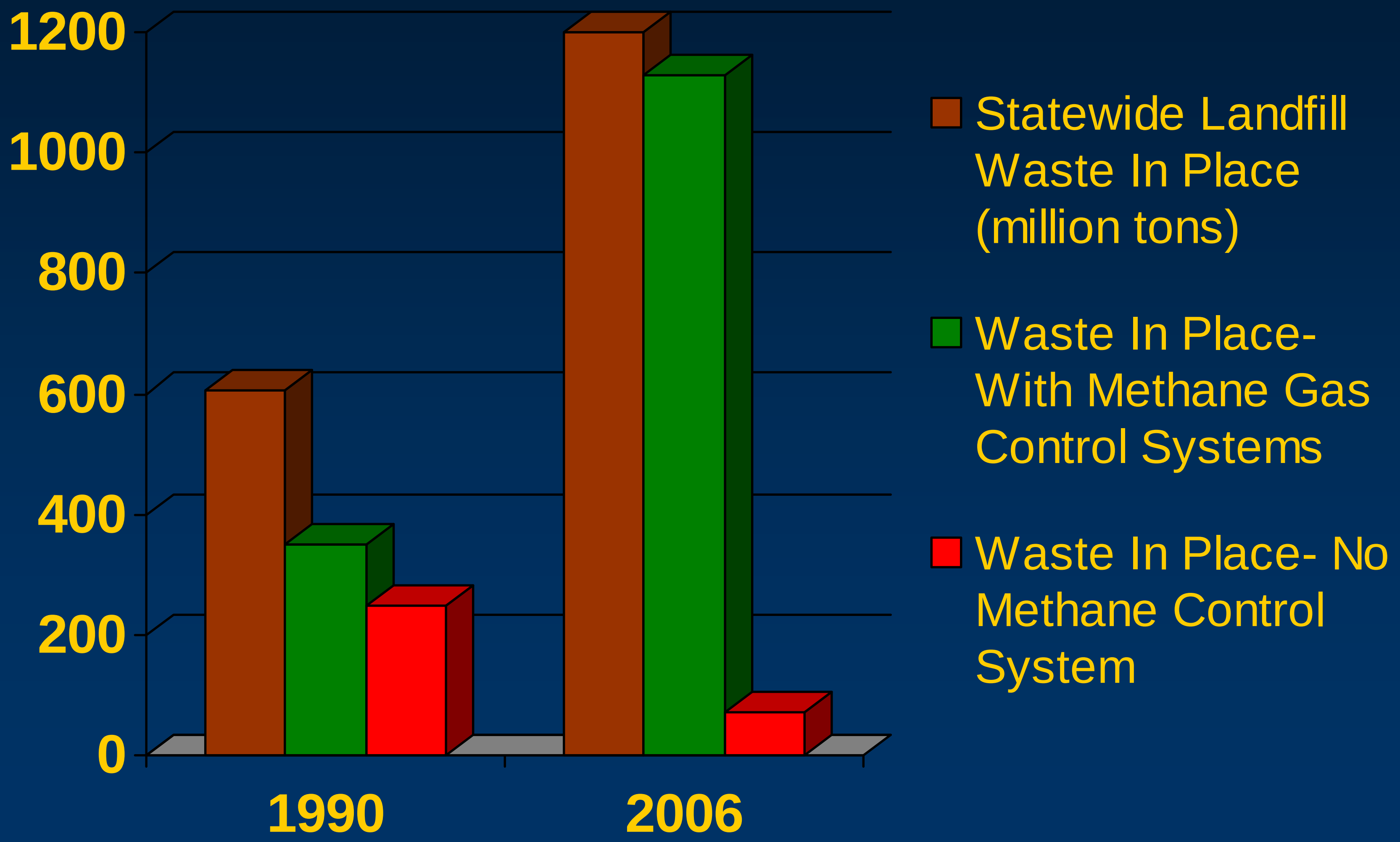
Landfill Methane Role in Greenhouse Gas Inventory

- AB 32 ARB draft GHG inventory released 8/22/07 (final by 1/1/08) www.arb.ca.gov/cc/ccei/emsinv/emsinv.htm
- Net 1990 GHG level is <u>436</u> MMTCO$_2$E required by 2020 (2004- <u>497</u>). Energy/Fuel Combustion (1A)- 392 in 1990 or 90% of total net emissions.
- Landfill methane (4A)- 6.58 MMTCO$_2$E in 1990 or 1.5% of total net emissions; in 2004 emissions reduced to 5.83 or 1.2% total.
- Livestock methane (3A)- 11.67/1990; 13.92/2004

Climate Action Team (CAT) Landfill Methane Capture Strategy

- Install new systems and increase methane capture efficiencies (included in AB 32 ARB Discrete Early Action Measure; estimated 2-4 $MMTCO_2E$ reductions)
- Increase recovery of landfill methane (>1.2 $MMTCO_2E$ in avoided emissions from offset fossil fuel combustion).

Landfill Methane Control Systems



AB 32 Discrete Early Action Measure

- One of three measures adopted by ARB will reduce landfill methane emissions by requiring control systems where systems not currently required and performance standards for maximum capture.
- Regulatory concepts released for public workshop on 10/10/07. www.arb.ca.gov/cc/ccea/landfills/landfills.htm
- Based on ARB actions, CIWMB to consider regulatory concepts within its purview if necessary to support ARB actions.

Landfill Methane Capture BMP Study

- CIWMB-funded ($150K) study by SCS Engineers to develop practical Best Management Practices (BMPs) to maximize landfill methane capture:
  - Early Installation of LFG System
  - Maximizing LFG System Design
  - Landfill Design/Operational Practices
  - Enhanced Monitoring and Metrics
- To be completed early 2008; will tie in with ARB Early Action Measure and CIWMB rulemaking.

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